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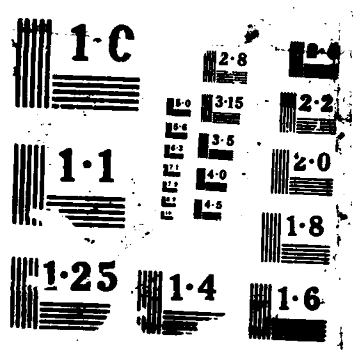
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The Scientific and Technical Information Network (STINET): Foundation for Evolution

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Gladys A. Cotter

September 1987

Defense
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Office of Information Systems and Technology

Cameron Station, Alexandria, VA 22304-6145

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This paper describes the advances which are being made in information retrieval systems to assist end-users and information specialists to overcome the critical barriers which make it difficult for them to exploit the power of these systems. Technology which is being applied to allow users to interact with information retrieval systems with greater ease and more successful results is identified. To illustrate this process, the efforts of the U. S. Defense Technical Information Center to develop and implement an integrated, functional, scientific and technical information network are described. This network was purposefully designed to incorporate both end-users and their information management intermediaries in a complementary manner making them resolute partners in the work and its rewards. The uses of technology modules -- artificial intelligence, expert systems, gateways, user-friendly interfaces -- to overcome user barriers are described in the paper.

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Gladys Cotter
Defense Technical Information Center
Cameron Station, Bldg. 5
Alexandria, VA 22304-6145

ABSTRACT

This paper describes the advances which are being made in information retrieval systems to assist end-users and information specialists to overcome the critical barriers which make it difficult for them to exploit the power of these systems. Technology which is being applied to allow users to interact with information retrieval systems with greater ease and more successful results is identified. To illustrate this process, the efforts of the U.S. Defense Technical Information Center to develop and implement an integrated, functional, scientific and technical information network are described. This network was purposefully designed to incorporate both end-users and their information management intermediaries in a complementary manner making them resolute partners in the work and its rewards. The uses of technology modules -- artificial intelligence, expert systems, gateways, user-friendly interfaces -- to overcome user barriers are described in the paper.

INTRODUCTION

The media hails the arrival of the information age, and we are told that information is the power of the future and that we are in the midst of an Information Revolution. From the vantage point of the information industry, the view is much more evolutionary in nature. Information has always equated to power, and we are exposed on a daily basis to the gap between media-induced expectations and reality.

The fact that information is a growth industry is indisputable. The number of online databases has increased from 301 in 1976 (Ref. 1) to more than 2800 in 1986 (Ref. 2). In the 1970s, several online services supported these databases. Currently, there are over 400 online services (Ref. 3). Advances

in data storage and retrieval capabilities have made it possible to store vast volumes of information online and to retrieve that information in seconds.

The proliferation of desktop computers has led to the vision of a "tactical desktop." Through the tactical desktop, all the information the desk occupant requires would be available by hitting a key, squeezing a mouse, pointing a finger, or issuing a voice command. This, in turn, has led to speculation that information retrieval experts soon will be without purpose, technologically obsolete. Examination of the facts reveals quite the opposite is true. New technology will strengthen the partnership between end-users and intermediaries. Through a combination of technology, imagination, and hard work we will step forward towards the ultimate information system.

BACKGROUND

The information retrieval systems environment consists of end-users, information specialists, database producers, and information systems vendors, using personal computers often linked into office automation systems. These information specialists, end-users, producers and vendors have been working together for years. Recent technological advances in the information systems field, the prevalence of personal computers in the office, and the introduction of office automation systems are changing the roles of, and the interaction among, the players. The culture of the information retrieval market is evolving, but the goal of the culture remains the same -- provide needed information in the most efficient and effective manner.

End-users are the individuals who need information. End-users run the gamut from student to chief executive officer, manager to technical expert. Their reasons for wanting information are as varied as the type of information they require and the format in which they find it suitable. Some end-users want a quick but accurate answer or fact while others merely want clues to aid them in their own discovery process.

Information specialists are intermediaries. Their expertise lies in identifying, retrieving, and delivering needed information to their client population -- the end-users. Information specialists have many tools at their disposal, the most powerful of which are the online retrieval systems. Through these systems, they can manipulate massive amounts of data, sifting through the volume and mining the relevant information with deft precision.

Database producers collect information and are responsible for the content of a database. Database producers may collect information of a certain type, such as all technical reports produced by the United States Department of Defense, or may

collect information in a certain subject area, such as geology. Some database producers perform indexing and abstracting services while others provide full-text information. Database producers make their information available through information system vendors. In some cases, the producer and the vendor may be one and the same.

Information system vendors provide the software and hardware to allow users to access databases online. Vendors control the quality and capabilities of the options available for retrieving the information. Database producers also control, to a certain extent, the search options which can be exercised in conjunction with their files. For example, a title search option is useless against a file which contains no titles.

Several years ago, the natural order of the information field was that database producers and vendors marketed their services and products primarily to the information intermediary, who was familiar with the content of the database and the retrieval mechanics provided by the system vendors. The information intermediary, in turn, marketed retrieval from information systems as one of the services available to end-users.

The market at that time was characterized by:

o Homogeneous system user characteristics. Users were information specialists who would devote the time to learn how to use online systems proficiently. Expertise in this area was a professional prerequisite.

o Complex systems. An online session required many commands, from logon to retrieval to printing.

o Unforgiving systems. Omission of a carriage return could be a fatal error.

o Extensive training requirements. There were multi-volume instruction manuals, multi-day introductory courses, and numerous advanced courses.

o Lack of standardization. If all systems are complex, a user who has mastered one will easily become "brand-loyal."

o Rapidly changing state-of-the-art. Information professionals struggled to stay abreast of the new databases and new information systems continually being introduced.

o A unique professional, the information specialist. Terminals and microcomputers were essential tools for their profession.

The essence of the market philosophy was that the information was available for those who had the time to dedicate or the need to develop the skills required to unlock the information banks. At the time, that was a sound philosophy.

Revolution Turned Evolution

The introduction of personal computers into the office (end-user) environment, combined with the developing awareness in end-users that the information available online could provide a competitive edge, played a major role in altering the above-stated philosophy. (The perception that the personal computer would become as commonplace as the telephone in the office and the home environment was probably more important than the reality.)

It did not take long for database producers and vendors to have visions of end-users armed with personal computers performing their own searching. Think how many hundreds of end-users exist for each information specialist. And, we all know that the amount of information end-users ask for is a function of the distance from their desk to the location at which the question must be posed. Reducing the distance between chair and answer to zero could have a tremendous effect on the end-users information needs.

The idea of doing their own searching appealed to many end-users. They were aware of the quantity of information available online to help them meet their goals. They could have all the information they ever wanted at their fingertips. The Information Age had arrived.

End-users, database producers, and vendors rushed to embrace each other. "The End-Users are Coming!" became a familiar cry throughout the information community. Information intermediaries were told their jobs were at risk as end-users learned to use remote terminals to unlock information sources.

Yet, for all of this fanfare, the predicted multitudes of end-users have not arrived yet, and direct user accessing of online information remains an almost arcane art. The encounter between the end-users, in their new role, and the information world yielded an important lesson:

Lesson One: As a general rule, end-users, unlike information intermediaries, will not devote extensive time learning to use a system.

End-users found that walking to the library was a lot faster than learning to use the retrieval systems.

Vendors then set out on a quest to find the perfect user interface. To attract end-users, the vendors would have to focus on making these interfaces "user-seductive." Several systems deemed to be "user friendly" were put on the market. More lessons were learned from this experience:

Lesson Two: Lesson One is the only general rule that applies to end-users across-the-board.

Lesson Three: End-users are a diverse group with many diverse needs. They require different types of data, different products and services, different user interfaces, and different marketing strategies.

Lesson Four: User-friendliness is an attribute which is bestowed by the user and not an innate state of being which is created through system design.

The interfaces that failed early suffered from the fact that the market was in its infancy and that end-users were viewed as a single market. As a result of these early painful experiences, the vendors began to segment the end-user market. Products, services, and market strategies were tailored to individual segments. Ease of use and variety of information were the key ingredients in the strategy for success and the foundation of a new market philosophy. Therefore, database vendors began investing in the development and application of new technology.

Which brings us to another important lesson:

Lesson Five: End-Users, even in the abstract, have considerable market leverage that benefits the entire information retrieval field.

The information systems that are evolving directly benefit information specialists as well as end-users. The continued evolution of information systems and accrual of benefits to the community will require a commitment from all involved parties.

The Challenge

As noted earlier, the number of databases in existence and accessible is increasing dramatically. This trend will continue, and we will see the addition of more "types" of databases. Numeric and factual databases will begin to number with bibliographic databases and eventually surpass them as more database vendors move toward providing full-text online.

The increase in the number of online databases means that there is more information, and more types of information, readily available. As more information becomes available online, the

probability of locating needed information also increases dramatically. Consider, for example, the ease with which details from a newspaper article can be located when full-text articles are available online. And, when information cannot be located online, we can conclude with greater certainty that the subject has not yet been covered in the literature.

The challenge which arises from having so much information available is how to provide selectivity. By what measures do we ensure that the proper sources are utilized and that relevant information is retrieved? How do we avoid leaving out important sources of information and retrieving volumes of irrelevant data? Some of the difficulties associated with this task are:

- Maintaining a constant alert for new databases/services.
- Registering for, and maintaining accounts with, each of the services.
- Selecting the right service(s) for the query.
- Learning the diverse command structures associated with each of the services.
- Becoming knowledgeable regarding the terminology used in each database.
- Merging and analyzing results from multiple services.

Many of these problems are being resolved through the application of new information technologies.

Technology to Meet the Challenge

Recent advances in information retrieval systems toward easier and more successful use have focused on developing and applying interface technology. These advances range from the development of a simple, interactive menu for searching a single system to the incorporation of gateway and artificial intelligence technology to aid the user in navigating through numerous, diverse information systems and culling out relevant information. The end goal is to allow users to interact with these systems via an expansive natural language interface, but the technology required for this effort is not mature enough to meet the task. In the interim, technology is in place that provides users with options for executing information searches. Some of the major alternatives are described below.

Interactive Menu. The objective of interactive menu development is to design the system so straightforward that a novice user can initiate the basic operations required to perform a search. The menus remove the requirement for the user to learn obscure retrieval protocols. Often the design incorporates an option of using a limited number of natural language commands or command abbreviations as the user becomes more familiar with the

system. These interfaces may be built into the information system itself or executed from a remote central processor or microcomputer system.

Common Command Language (CCL). The CCL alternative requires that the user know, or is willing to learn, at least one set of database retrieval commands. The CCL may be based on a national or international standard for database retrieval commands, or the CCL may be a system's existing commands which are translated, transparently to the user, to other systems' languages so that other systems respond to the same commands. Systems are being developed which provide the user with the choice of using a standard or an existing command structure. The CCL interface may be built into the information system itself or executed from a remote central processor or microcomputer.

Gateways. Gateways allow users to interconnect with multiple, diverse information systems. In essence, gateways act as intelligent switches. The level of intelligence is based on system design. At the lowest level of functionality, gateways handle the computer protocol and handshaking so that systems can talk to one another. Basic capabilities beyond simple interconnection include a design that relieves the user of the need to register for multiple systems, to learn telecommunication paths and protocols, and to memorize system logon and logout procedures. More advanced gateway systems incorporate menus, common command language, data analysis routines, artificial intelligence, and related technology.

Gateways can be run in environments ranging from single-user microcomputers to multi-user, central processing mainframes. The number of resources targeted for interconnection, the number of users, and the "intelligence" required in the gateway determine the configuration requirements.

Knowledge-Based Interface. Menus, common command languages, and gateways bypass significant barriers to information retrieval, but they have not broken through the human language barrier. Through the development of knowledge-based interfaces, we are inching towards the goal of natural language search interfaces. Knowledge-based systems use artificial intelligence (AI) to make the human-machine interfaces more human-like and more natural. The system performs in a manner that simulates intelligence; it makes educated decisions. To get a system to this point, we must build a knowledge base similar to that of a human expert. This requires analyzing the knowledge that the human has and the thought processes used to make decisions. AI programming tools can then be used to program this knowledge into the system. The result is often called an "expert system."

Building a knowledge-based system is a complex task. The system is usually limited to a narrow subject scope. To be successful, the system must be programmed with a thorough knowledge of the subject area and the natural language used by human experts and their clients. Designing an interactive natural language interface is a difficult task. Most of the knowledge-based information system interfaces designed thus far relate to medical information. A cancer research file is an example. The medical field has a fairly standard vocabulary which makes it a good candidate for an expert system. An expert system with the knowledge of a librarian or information specialist is not now possible, and a development of such a system is a long-term effort at best. But overcoming the communication barrier a function at a time through use of the appropriate technology, whether menus or gateways or artificial intelligence, is essential to the continued evolution of information systems. It becomes even more critical as the volume of data we have to deal with increases.

The table below provides a sampling of interface software on the market today (Ref. 4). This list is by no means exhaustive. It notably omits noncommercial products which have been developed by the government and university communities. However, it does provide an indication of the interest and activity in the interface field.

Table 1
Representative Interface Systems

Software System	Function	User Level
BCN's Super Scout	System access to 15 services including DIALOG and Western Union's Easy Link (electronic mail)	Novice
EasyNet	System access to more than 10 services including DIALOG, SDC, BRS and NLM	Novice
IN-SEARCH PRO-SEARCH	System access to DIALOG and BRS with cross-system emulation and general telecommunications capability	Novice Expert
INSTANTCOM	Upload/Download. General telecommunications to DIALOG, BRS, Dow Jones and other systems	Intermediate
MCI Mail	Electronic mail and system access to Dow Jones and other systems	Novice
PC/Net-Link Net Search	System access to DIALOG, SDC, NLM, Dow Jones, Lexis, OCLC, RLIN, Westlaw. Questel and Newsnet with database manager (Net Search)	Novice
PC-Talk	Upload/Download. General telecommunications capabilities	Intermediate
SciMate	System access to ISI, DIALOG, BRS and NLM with optional database manager	Novice/ Intermediate
Search Helper	System access to six Information Access Co. databases on DIALOG	Novice
Searchmaster	System access to SDC, BRS, DIALOG and NLM	Expert

CASE STUDY

The following case study describes the efforts of the U.S. Defense Technical Information Center (DTIC) to develop and implement an integrated, functional scientific and technical information network. This network was purposefully designed to incorporate both end-users and their information management intermediaries in a complementary manner making them resolute partners in the exploration of how new technology can be applied in an actual information service environment.

In 1980, the U.S. DTIC was assigned functional responsibility to develop and implement a coordinated Scientific and Technical Information Network (STINET). The purpose of the network was to facilitate DoD access to scientific and technical information relevant to DoD mission areas. Key elements of the STINET were identified as: DoD managers and scientists; DoD Libraries and Information Analysis Centers (IACs); DoD Laboratories; DTIC; and other DoD federal, commercial and foreign databases, systems and sources of STI. DTIC was tasked to provide a focus for molding the STINET, establish interoperability among the various network components, and coordinate network evolution. DTIC was to achieve this vision by promoting resource sharing and cooperative efforts and through investigation, experimentation, and application of advanced information science and technology.

Development of a STINET was a huge and challenging task which had to be accomplished within existing financial and personnel constraints. In order to make visible progress towards the STINET, DTIC had to carefully identify network requirements and evaluate the currently available technology in which applied research could be invested in both the short term and the long term to meet these requirements. Next, DTIC had to settle on an agenda of purposeful steps that would close in on the ultimate goal. Successful development and implementation of the network would depend on devising a "doable" plan of work with room for deviation when opportunities for technological acceleration became apparent.

The following elements would be required for a successful network:

- o interoperability and interconnection
- o tools such as pointers and menus, to help locate information
- o standardized command functions
- o compatible, multifunctional, flexible software for installation at network nodes
- o interconnection with diverse sources of information including government, commercial and foreign

- o interconnection with diverse types of information including numeric and factual.
- o selectivity and data analysis routines
- o improved delivery systems
- o integration of databases and people bases

The technology needed to meet the requirements of the STINET was at various stages of readiness. DTIC selected several key and promising areas in which to invest development efforts. The goal of these development efforts was to provide the basic foundation for, and functional capabilities of, the STINET. These efforts are summarized in Table 2 on the following page.

The DoD Gateway Information System, the Integrated Bibliographic Information System and the SearchMAESTRO system (described below) provide examples of how this technology is being developed, applied and integrated to provide easier and more successful information retrieval.

The DoD Gateway Information System (DGIS)

In 1983, DTIC initiated development of the DoD Gateway Information System (DGIS), an intelligent gateway system which would provide distributed networking, electronic communication, and information access and analysis. The DGIS was to link people, information services, and computers pertinent to the STINET. The technology embodied in the DGIS would provide the key menus, pointers, interoperability, and interconnection within the STINET. To accomplish this, DGIS would have to function as an electronic switch, a translator, a communications interface, and a transaction controller. DGIS would require a variety of alternatives, tailored to different user types and needs, for obtaining and distributing information.

DGIS focuses on streamlining the information retrieval and analysis process. This is accomplished by placing the user at the center of a vast information universe consisting of people bases and databases and providing the user with the navigational tools required to pinpoint and arrive at his destination. In terms of databases, the DGIS is designed to provide users with answers to the questions:

WHAT RELEVANT DATABASES EXIST?
HOW DO I ACCESS THEM?
HOW DO I RETRIEVE INFORMATION FROM THEM?
HOW DO I MANIPULATE THE RETRIEVED INFORMATION?

The DGIS provides a single, easy-to-use interface for identifying, accessing, interrogating, and post-processing information from numerous databases relevant to DoD information needs.

Table 2
Scientific and Technical Information Network (STINET)
Initial Development Efforts

Legend: Current ● Planned 0

Development	Network Function/Description	Characteristics: Classified	Unclassified	Multi-User System	Single-User System	Stand-Alone System	Integrated Module
Gateway *Prototype: DGIS*	Provides the backbone of the network. Allows interoperability and interconnection. Interface incorporates menu and English-language commands. Accomplishes automated connections to diverse, geographically distributed resources, simultaneous searching, data uploading/downloading, and file transfer. UNIX operating system.	0	●	●	0	●	●
Local Automation Model (LAM) *Prototype: IBIS*	Provides the capability to create and maintain a local database/catalog in a network-compatible manner. Unifies methodology for using internal and external resources. Provides information control mechanisms such as a circulation system. Prototype implemented using an integrated library system merged with an intelligent gateway.	●	●	●	●	●	0
Directory of Resources *Prototype: Dir. of Databases*	Provides pointers and menus to help locate information. A prototype Directory of Databases is in operation, implemented using the INGRES Database Management System. A Directory of Experts and a Directory of Computing Resources are planned.		●	●	●	0	●
Common Command Language	Provides a standardized set of commands for searching diverse databases. Implemented in C-Language for a limited set of databases. Switching to PROLOG for a production version.	0	●	●	0		●
Post-Processing	Provides a tool box of utilities for selecting and analyzing relevant data. Dependent on translating data to a common format for manipulation. Implemented in C-Language and UNIX scripts.	0	●	●	0	0	●
End-User Interface *Prototype: Search-MAESTRO*	Provides a mechanism for users who do not possess retrieval expertise to search diverse databases. Implemented using the EasyNet service from Telebase Systems, Inc.	0	●	●	0	●	●
Expert Connector Intermediary/Expert Link	Provides a mechanism for establishing people bases or an expert network. Information experts can be linked with end-users. Implemented using the electronic mail system developed by Lawrence Livermore National Laboratory, the UNIX Link command, and the SOS capability of Telebase Systems, Inc.		●	●			●
Electronic Document System	Provides mechanisms for digital input, storage, and delivery of full text. Will improve selective delivery of information to users. Concept development stage.	0	0	0	0	0	0

In terms of people bases, the DGIS is designed to answer the questions:

WHAT EXPERTISE IS AVAILABLE ON THE NETWORK?
HOW DO I COMMUNICATE WITH EXPERTS?
HOW DO I SHARE INFORMATION WITH COLLEAGUES?

The DGIS acts as an integrated information system which allows human experts, information users, and information resources to exist and interact in harmony.

Development of DGIS is a multi-year, multi-task project. A prototype system has been developed. The basic components of the system are:

A DIRECTORY OF RESOURCES, SUBJECT SEARCHABLE
A COMMON METHOD FOR ACCESSING AND SEARCHING DIVERSE DATABASES
TOOLS FOR DOWNLOADING AND POST-PROCESSING DATA
TOOLS FOR COMMUNICATING WITH A NETWORK OF EXPERTS AND COLLEAGUES

DGIS was designed for a DoD user community including both intermediaries and end-users. Databases accessed are federal, commercial and international. In addition to large, well-known databases and systems, many small, specialized DoD databases will eventually be part of the DGIS.

Once the broad requirements for DGIS were identified, a software survey was conducted to determine if a software product already existed which would meet DGIS needs. The survey showed that THE system was NOT out there, waiting. One software package, the Technology Information System (TIS), did provide a suitable foundation on which to begin constructing DGIS (Ref. 5). TIS was under development at Lawrence Livermore National Laboratory (LLNL) under the sponsorship of the Department of Energy (DOE) (Ref. 6). TIS functioned as an intelligence gateway capable of interconnecting heterogeneous information resources at geographically distributed locations in an automated, unified, and controlled manner. In addition, TIS downloading and post-processing capabilities were already available for selected databases. Therefore, TIS was used as the baseline for developing the DGIS.

<u>Director of Resources</u>

The Director of Resources will include subdirectories with references to databases, people, and computing resources. In the first phase, the Directory of Databases is being developed; this is described below. The Directory of People will contain references to experts in subject areas and information retrieval

techniques who may be contacted via the network. The Directory of Computing Resources will contain references to computing resources, such as supercomputers which can be used for data analysis and modeling, available through the network.

In order to develop a Directory of Databases, it was necessary to identify and catalog existing databases and make that information subject-searchable, so that user information needs can be matched to relevant resources (Ref. 7). Although there are many directories that identify commercial and prominent federal databases, such information was not readily available for DoD databases. To fill this void, a questionnaire was addressed to the DoD Research and Development (R&D) community to identify existing databases, their scope, and availability. Over 400 databases were identified (Ref. 8).

The next step was to build a database of the DoD and DoD-relevant databases which had been identified. A user survey was conducted to determine database requirements (Ref. 9). A database scheme was development for the Directory, and database entries were subject indexed. The database was built using the INGRES relational database management system.

The result of this effort is an online Directory of Databases which contains information on the content, scope, and availability of selected databases. The Directory of subject-searchable; upon entering a topic of interest, the user is provided with a list of appropriate databases.

Interfaces for Searching Diverse Databases

One of the primary goals of DGIS is to relieve the user of the need to learn and master separate commands and protocols for each database access. As mentioned earlier, the DGIS target user community includes both end-users and intermediaries. It is a rare intermediary who maintains proficiency in the use of more than five systems; for end-users, two systems is high (Ref. 10). With the ongoing proliferation of databases, it is obvious that both end-users and intermediaries will benefit from an interface for searching diverse databases. DTIC found that end-user and intermediary interface needs are very different when considered in conjunction with today's technology. An expansive natural language interface requiring artificial intelligence applications appealed to both populations, but could not be accomplished with existing technology in the short term.

A dual approach was adopted for the interface design, incorporating separate strategies for intermediaries and end-users. Eight database systems were selected for inclusion in the prototype. These included three large federal systems and two small DoD systems.

A software survey was conducted to determine if interfaces existed which met DGIS needs. One need that influenced the result of this survey was the requirement to support low-end, "dumb" terminals, as well as intelligent devices, on DGIS. Many of the software packages identified were designed for a microcomputer environment and had to be ruled out for use in the prototype. As a result of the survey, a decision was made to develop an interface for the intermediary and to integrate an existing interface for the end-user.

For the intermediary, a command translator is being developed which allows the user to interact with any of the test systems using the command language he selects. The user, for example, could search NASA/RECON using DROLS commands or the reverse. Since some commands will not have an equivalent in another database, native command searching will be retained.

To satisfy the end-user, the EasyNet database searching service has been integrated into DGIS under the name SearchMAESTRO. SearchMAESTRO is a menu-driven database front-end which provides access to over 900 commercial databases. This service was tested by members of the DoD end-user community who were delighted with the simplicity of search execution. In addition, a SearchMAESTRO interface to the DTIC Technical Report database has been developed. SearchMAESTRO access is now an option within DGIS and is described in greater detail in a later section of this paper.

Post-Processing

Information retrieved from databases often requires analysis or post-processing in order to become useful to the researcher. DOE recognized this need and developed many options for post-processing data from DOE/RECON through TIS. A library of post-processing routines for numeric and bibliographic data was available on TIS software and was incorporated in the DGIS project (Ref. 11). In order to post-process data, the user downloads it into a file on DGIS, translates the data into a common format, and calls up one of several available post-processing routines.

DTIC tested existing post-processing capabilities, developed recommendations for enhancements, and established priorities for the expansion of the capabilities to other databases.

DGIS User Interface Design

The interface incorporated in TIS software was structured to support users with a knowledge of the UNIX operating system. As a rule, the DGIS user community lacked this knowledge and was not inclined to invest the time required to acquire UNIX expertise.

However, TIS software had a flexible design which allowed the user interface to be tailored to the DGIS user community.

The DGIS interface incorporates menu and command modes (Ref. 12). The objective was to allow the novice user to interact with the system with ease, by descending through a series of menus. For the more experienced user, commands to execute systems functions were incorporated. The main menu of the DGIS which shows the overall processes of DGIS, is as follows:

```
0            WELCOME TO THE DoD GATEWAY INFORMATION SYSTEM


      >>>>>>>>>>> INFORMATION TRANSFER MODULES
      1           directory        DGIS Directory of Online Resources.
      2           communicate      Connect to information resources and people.
      3           process          Information product tailoring.

      >>>>>>>>>>> INFORMATION UTILITIES
      4           em               Electronic Mail.
      5           files            File operations.

      >>>>>>>>>>> SUPPORT INFORMATION
      6           help             Description of features.
      7           users            DGIS registered users.
      8           info             DGIS news and information.
      9           dticlog          DGIS full text retrieval.

      DGIS HOTLINE NUMBER: (703) 276-8182
      or send questions via DGIS EM to 'dgishelp.'

Enter a menu number, a command, "b" to backup, "t" for top, or "e" to end.
*
```

People Bases and Databases

The goal in obtaining information is to acquire knowledge. Much of the information we need resides in the minds of human experts. Therefore, the DGIS has been designed to allow interaction among people, hence the concept of people bases as well as databases.

Through the DGIS, users will be able to identify and communicate with experts and colleagues and to connect to information resources. As a first step, we have focused on providing the technology to allow such interaction. The DGIS menu for communications, shown below, illustrates how we are integrating databases and people bases. Users can access a search interface, a database/system, or people.

•2

2 COMMUNICATIONS

DGIS will automatically connect you to a wide range of remote information systems and to other people online the DIGS. For information systems, you must have already registered with these systems and have provided DGIS your access passwords. Select as follows:

>>>>>>>>>> SEARCH INTERFACES

2.1	maestro	SearchMAESTRO - menu driven search aid.

>>>>>>>>>> NATIVE MODE

2.2	multi	access multi-type information systems.
2.3	factual	access factual and numeric databases.
2.4	media	access news services.

>>>>>>>>>> OTHER COMMUNICATIONS

2.5	dial	unassisted dial into other systems.
2.6	people	communicate interactively with DGIS users.

Enter a menu number, a command, "b" to backup, "t" for top, or "e" to end.

•

Accessing a database/system is accomplished using the CONNECT command or the DIAL command. The CONNECT command provides users with automatic access to information resources. Users do not have to know telephone numbers, Defense Data Network (DDN) locations, passwords, access protocols, or logout protocols. The user enters the CONNECT command and a data resource name. DGIS then establishes a connection to the resource when the connection is made, DGIS logs the user in. DGIS uses TYMNET, TELENET, DDN, and commercial telephone lines to establish connections.

The CONNECT command can be used to access information centers worldwide. To be eligible to use the CONNECT command to access a resource, a DGIS user establishes an account with that resource and obtains the required access identification information, such as passwords, which is then programmed into the gateway by the DGIS Database Administrator. The billing process between user and resource is unaffected by.gateway access. Vendors maintain the same billing structure and users maintain the same reimbursement structure, regardless of the access procedures. DGIS has several levels of security to ensure that password integrity is not violated.

As the number of resources DGIS connects to increases, we plan to have DGIS accounts that will alleviate the need for users to establish their own accounts with each vendor. To this end we are now developing a charge-back mechanism so that we can bill users for their use of these general accounts.

Users who wish to access a resource that does not have an automatic connection routine can take advantage of the DIAL command, rather than the CONNECT command. DIAL allows users to call any information center, computer, or terminal, no matter where the location. To use DIAL, the user must know the necessary passwords and telephone numbers. DIAL allows the user to access an off-network facility while retaining DGIS capabilities such as downloading and file transfer.

Once connected to a resource through DGIS, a user can download data from that resource to DGIS. Downloading data opens many options. For example, data can be reviewed at leisure, merged with other data, and shared with other users by allowing them to access the file. Data files can also be transferred to other users so that they can manipulate the data to suit their own needs. DGIS allows data to be shared selectively on a worldwide basis. The user is responsible for ensuring that copyright laws are not violated.

Several mechanisms are available for interconnecting people. An electronic mail service is available twenty-four hours a day. Standard electronic mail features such as send, receive, answer, and forward are incorporated. Mail messages can be sent simultaneously to multiple addresses and to every member of pre-established mail groups, with lengthy documents attached if needed. Users recognize the benefits of being able to communicate with numbers of people at the same time and of avoiding the "telephone-tag" routine. Messages can be filed for future reference or deleted from the system upon command.

In addition, electronic mail can be used to send information downloaded from a database and placed in a file. A user who does not want to do his own database searching can send a search request to an information specialist without leaving his desk. The information specialist can perform the search, download the results to a file, and send the file to the user. Since the data is stored in a file, both the information specialist and the end-user can use post-processing routines for manipulating and analyzing the data. The user can share the file with colleagues by using the electronic mail feature.

WRITE is another communications option which allows users online to communicate with each other via their terminals. To establish a WRITE session, the user first enters the command %WHO to get a display list of the users currently online. The user then enters the command %WRITE, followed by the name of the user with whom he wishes to communicate. The WRITE command notifies the party being called, who then has the option of responding. The command TALK is a variation of the WRITE command which provides a split screen so that both parties can input at the same time. The WRITE and TALK commands are only useful, of course, when parties who want to communicate are logged on, by chance or arrangement, at the same time.

The LINK command allows two or more users at different locations to link their terminals so that they view the same data display. All users have control over the display and can issue commands at will. Of course, linking necessitates a cooperative spirit and some coordination.

Through the LINK command information specialists and end-users can together perform interactive database searches. The end-user benefits from the specialist's expertise, while the specialist benefits from the end-user's immediate feedback.

The LINK command can prove advantageous in many other situations. For example, an instructor can provide online tutorials to a student or a class at a different location. This technique was used by Dr. Sullivan of the Chemical Information System (CIS), in Washington, DC, to provide a demonstration of CIS to a class in Brazil. The use of a speaker phone enhanced this demonstration by providing simultaneous voice communication.

The LINK command is also useful for joint online editing or reviewing of reports among experts. This practice eliminates mail delays and allows experts to discuss changes while viewing the data together.

User Support

As implementation and testing of the various DGIS modules began, it became obvious that some form of user support and training was required to ensure the success of the system. A Gateway User Support and Training Office (GUSTO) was established to satisfy this need (Ref. 13). GUSTO provides a hotline service which users can call when they have a problem. GUSTO staff will identify the source of the problem (i.e., the gateway, the user's terminal, a telecommunications link, a remote system, etc.) and take action to have the problem resolved. Users may also contact GUSTO staff using the electronic mail capability available on DGIS.

Developing user's manuals and providing training courses are also GUSTO responsibilities. The training course is primarily designed for the professional searcher who wants to exercise the full power of the system, especially in the area of post-processing of bibliographic data. The user's manual serves as a reference tool for the user. GUSTO staff also poll the DGIS user community as needed to identify new system requirements.

Prototype and Beyond

A prototype DGIS has been developed and is currently undergoing test and evaluation within the DoD community. There are currently 150 users testing the system. The DGIS prototype

is running on a VAX 11/780 using the UNIX operating system, the INGRES database management system, and the PROLOG interpreter package. The DGIS software is being ported to a Pyramid 98X, an Elxsi 6800, a Gould 6050, and Sun Workstations for benchmarking and performance evaluation. Based on the results of the performance evaluation, a hardware configuration for a production system will be acquired. The production configuration may consist of several machines networked together. For example, the common command language and post-processing routines could be isolated on a back-end machine. DTIC plans to stabilize a version of the DGIS and offer it as a standard DTIC service in October 1988. Prototype development will continue on a separate development machine, and enhanced versions of the DGIS will be made operational at selected intervals.

The DGIS was developed in prototype as an unclassified, minicomputer-based centralized gateway system. As we move this version into operation, we plan to begin development of a distributed, clustered gateway network. Gateway nodes in the network would be made up of centralized, multi-user configurations and intelligent workstations distributed to users. A selection of gateway capabilities would be available on personal workstations. It makes sense, for example, to have automated connection routines, common command languages, and post-processing routines for frequently-used databases available on a personal workstation. The centralized, mini-based node would be utilized to identify and search infrequently-used resources and for post-processing volumes of data which are beyond the capacity of the personal workstation. Clustered gateway nodes consisting of a centralized gateway processor and personal workstations could be based on geographic, organizational, or subject boundaries. The clustered gateway nodes would interconnect and route users to appropriate nodes when necessary. Development of a classified gateway system is also underway.

Integrated Bibliographic Information System (IBIS)

Development and implementation of the DGIS allows DTIC users to connect to, and search and analyze data retrieved from diverse unclassified database services in the federal, commercial, and international sectors. Development, as planned, of a classified version of the DGIS will make its reach almost limitless. But what the DGIS has not provided is tools for the development of local databases or catalogs of holdings and tools for local collection management.

The DGIS was designed as an intelligent switching mechanism. The resources targeted by the DGIS were already online. DGIS was designed only to switch users to automated resources. The

Directory of Resources is the only database central to and created and maintained on the DGIS. This is a basic design philosophy, not to be altered for fear of deflecting the DGIS from its primary focus -- that of being a gateway.

But there was a need to provide a vehicle to automate and manage local information collections which are manually maintained, very valuable, and very difficult for non-local personnel to use. This need is acutely felt by the DoD library community, a key component of STINET.

Therefore, in 1983, DTIC initiated development of a library automation system responsive to the networking and local collection management needs of DoD libraries. The system would support centralized resource sharing while allowing local processing flexibility. The objective was to permit DoD libraries to make maximum use of existing information, organize this information to meet local needs, and selectively share newly-generated information with other members of the community. The system designed to accomplish this would have to integrate local control for local collection management functions (reference, cataloging, and circulation) with access to the external resources required for reference, shared cataloging, and other network requirements.

The automation needs of the DoD libraries were defined through a requirements study initiated in 1983, which included surveys, site visits, and staff interviews throughout the DoD technical library community (Ref. 14). Based on this study, a prototype system to meet these requirements was specified, and its development became the objective of the IBIS project. The requirements that IBIS is expected to satisfy are summarized as follows.

Local Collection Management: Local cataloging, retrieval, and circulation capabilities are essential IBIS system requirements. Acquisition and serials management functions are desirable system features; they will be added at a later date.

External Database Access: System capabilities to input data to and retrieve data from external databases are critical. Uploading and downloading capabilities are essential. The DTIC TR database is a primary external resource; DTIC TR access by IBIS is vital to the cataloging and reference functions of the libraries.

Integration of Local Collection Management and External Database Access Capabilities: These capabilities are to be integrated on one computer and accessible by an authorized user from a terminal equipped with video display screen.

Common Command Set for Performing Functions Locally or Externally: A single command language is necessary for users. The IBIS will perform the necessary protocol translations between the single command language internal to IBIS and the diverse command structures of the external databases. The common command set will relieve the user of the need to learn and master separate languages and procedures for each database accessed. However, "native" language access to external databases must be available to the user.

Simultaneous Access to External Data Sources and the Local Catalog for Reference Searching: The libraries are to be able to run the same search query against multiple databases, local and external simultaneously. Search results are to be delivered to a single terminal.

Post-Processing of Retrieved Data: The ability to reformat, merge, and sort data downloaded from external sources is a desirable feature. This capability will allow libraries to fit search results -- derived from external sources and the local catalog -- to their patron's needs and deliver a single product in an economical and efficient manner.

Flexible Local Catalog Format: The IBIS format must be flexible to accommodate the diverse local catalog formats used throughout the DoD community. A flexible local catalog format will encourage wide IBIS implementation. This approach avoids the delays and extraordinary expense that would be required to resolve the issue of cataloging standardization within the DoD.

Machine-Aided Citation Translation and Uploading to DTIC: The IBIS must assist in translating bibliographic citations from the local file format into the DTIC format. This capability will allow DoD libraries to contribute data to the DTIC TR database directly and efficiently. This information will then be available to the entire DoD Community for display and downloading. The resulting shared cataloging will contribute significantly to meeting the resource sharing goals set by DoD.

Patron Access: IBIS will verify a patron's right to access before releasing information classified a Defense-sensitive or otherwise restricted. In addition, the IBIS will provide for online communication, as allowable by local security regulations, between patrons and the library staff and among patrons/colleagues themselves. In some instances, this will require that IBIS be connected and a local area network.

From Concept to Prototype. The design concept for the IBIS was formulated from the foregoing requirements. A software survey was conducted to determine if commercially available

software packages could provide the capabilities required to implement this concept directly (Ref. 15). A list of 30 critical software functions was compiled and used to conduct the survey. Reference sources, such as the Data-Pro Reports and the Library Systems Evaluation Guide, were used to identify software packages specifically intended for application in the library environment. A total of 66 potentially suitable packages were identified, and their vendors were asked to respond to the survey. Analysis of the responses showed that three of the survey questions were key. They were:

- Does your package support online:
  - Cataloging (to include online catalog updating)?
  - Reference/Catalog search and retrieval?
  - Circulation management and control?
  - Serials management?
  - Acquisition management?
  - Others?

- Does your package have a gateway capability that includes:
  - Queries of "second" external database (heterogeneous)?
  - Downloading/retrieval?
  - Uploading/cataloging?
  - Post-processing?
  - Telecommunications link, auto-dialing, log-on?
  - Single query language?

- Does your package preclude running other applications not part of your package?

The answers to the first two questions eliminated the notion that a "perfect" software system was available. No single commercial or public-domain system provided the capabilities required to implement the IBIS concept. Integrated library systems that supported cataloging and reference functions existed, as did gateway systems that supported the querying of external databases, uploading, downloading, and simultaneous searching, but no software combined these functions. In addition, no software package could be identified that contained a suitable common retrieval language, or one which the vendor was willing to adapt to satisfy the database access requirements of the DoD library community.

It was the responses to the third question which gave hope that a tractable solution was possible. The approach chosen was to combine an integrated library system for local library collection management with a gateway system for accessing external resources. The intelligent gateway processor embedded in the DGIS was designated as the gateway portion of the IBIS. It would support access to external resources, data downloading

and uploading, simultaneous searching, and post-processing. The common command language which DTIC was developing for DGIS would be made available for IBIS also.

Of the 66 library system packages identified, six were determined to have the requisite features. These six packages were benchmarked, and a selection was made in August 1985. At that time, the integration of the selected packages with the gateway software began.

The Defense Nuclear Agency (DNA) was selected as the prototype site for the IBIS. The DNA library, like many of the libraries surveyed during the requirements definition phase, had a collection of more than 100,000 holdings and required a system supporting multiple users. The IBIS prototype was implemented at DNA on a VAX 11/750 minicomputer.

Scaling Down. In the initial stages of the IBIS project, it was believed that the production system design selected as a result of the DNA prototype test would be suitable for implementations throughout DoD. However, it was determined during the software survey that most library packages are designed to operate efficiently over relatively narrow ranges of collection sizes and transaction volumes. The hardware configurations selected by the various vendors to run their different packages reflected this tendency. It then became evident that a distinct IBIS configuration to support smaller DoD libraries would be needed.

The hardware configuration required to support the prototype IBIS at DNA, a minicomputer-based system, was not economical for smaller DoD technical libraries with collection sizes ranging from 5,000 to 75,000 items. A microcomputer-based system was more appropriate for the lower transaction volumes and smaller operating budgets associated with these libraries. Therefore, DTIC initiated an effort to identify and isolate the special requirements of these smaller DoD libraries and accommodate them. A software survey was performed to identify packages which were suitable for servicing these smaller libraries and at the same time were compatible with the gateway software. The U.S. Army Training and Doctrine Command (TRADOC) library was selected as the prototype site for the microcomputer-based version of the IBIS.

Future Plans. The results and experience gained during the test and evaluation of the DNA and TRADOC prototypes will be used to develop the specifications for a competitive procurement of a production system from a commercial source. The production system will be available for purchase and installation by any library on the STINET. As a result of the dual approach -- small and large libraries -- an IBIS product line which can meet the

needs of any DoD library, regardless of collection size and transaction volume, is expected to result. This product line is expected to be available to the DoD user community in the summer of 1988.

The IBIS is the first of DTIC's Local Automation Models and will make network-compatible software available for local installation and use. The IBIS is tailored for bibliographic information, and its target community is DoD libraries. Later, Local Automation Model product lines can be tailored for other user communities and different types of data. For example, models tailored for numeric data may be a requirement for some communities. Depending on the software selected for the production IBIS and the non-bibliographic user requirements identified, it may be possible to modify the IBIS software to meet additional needs. If not, DTIC can develop additional network-compatible local automation models specifically for an identified defense requirement.

Successful development and deployment of the DGIS and IBIS will provide DTIC with a powerful product/ service line for the STINET. Through STINET, users would have a mechanism for interconnecting with a virtually endless range of information systems, computing resources, and people. They would also have a network-compatible vehicle for automating and managing local information, selectively sharing that information with other members of the network, and analyzing information from local and remote resources.

SearchMAESTRO

Both DGIS and IBIS were designed to deliver the power and utility required by a broad section of DTIC's market. But part of DTIC's market did not require the full power of the DGIS and the IBIS. This segment consisted of end-users who wanted to do some of their own information gathering. The users in this market segment had the requirement to scan literature and locate relevant items in their area of interest. They needed an interface that would provide easy access to a variety of databases. In some cases, the users would not be familiar with existing databases, so they required a system that would select a database for them and guide them through the search process. The information needs of these users tended towards fact retrieval -- such as the latest production statistics for a manufacturing company -- or scanning for relevant items -- such as what newspaper articles have been written on a particular subject. Their need was for some information relevant to the subject rather than an exhaustive search of the subject. We refer to them as casual end-users.

For this segment of the community, DTIC introduced SearchMAESTRO. As mentioned earlier, SearchMAESTRO provides access to over 900 databases. SearchMAESTRO can be used directly or through the DGIS. Users who access SearchMAESTRO directly can access databases via a simple-to-use interface. This interface eliminates the need to learn unique database command languages and search techniques. The user has two modes of operation from which to choose. In the first mode, SearchMAESTRO leads the user through a series of questions and answers and select the database for him. An example of how this works is shown on the following page.

In the second mode, the user can select the database he wants and use the SearchMAESTRO interface for executing the search. With either mode, the user can view search results on the screen, print, or save the results using local equipment. The main reason for accessing SearchMAESTRO through the DGIS is to take advantage of the post-processing and electronic mail utilities. The users must always observe fair use practices when dealing with copyrighted material.

The unclassified portions of the Technical Reports and the Work Unit Information System files of DTIC's Defense Research Development, Test and Evaluation Online System (DROLS) are being made available to registered users through SearchMAESTRO.

Any time man and computer meet, a diversity of problems arise which can best be handled through human intervention. Therefore, SearchMAESTRO provides online user assistance through a function called "SOS" for "Save Our Search." At any point during a SearchMAESTRO session, the user can simply enter "SOS" and a search expert will respond. The search experts are trained to interpret reference questions, be knowledgeable about available sources of online information, and know how SearchMAESTRO works. DTIC supplies the search experts for the DROLS files, and Telebase Systems, Inc., supplies experts for all other systems.

SearchMAESTRO is currently available as a prototype to approximately 30 users. These users access SearchMAESTRO both directly and through the DGIS. The SearchMAESTRO service will be offered as a DTIC production service in October 1987.

SearchMAESTRO is just the first of several end-user interface options we plan to offer our users. DTIC has sponsored two conferences in the area of interface technology and maintains a constant alert for new offerings (Ref. 16, Ref. 17). We are especially interested in expert systems and personal computer-based interfaces.

Password accepted.
Almost There. Be patient.
Finally done. Its about time.

Login into SearchMAESTRO is now complete.
To logout, press <ESC> <CTRL> D

```
PRESS       TO SELECT

   1     SearchMAESTRO - I        We pick the database
   2     SearchMAESTRO - II       You pick the database
   3     Database directory
   H     Help
-> 1

PRESS       TO SELECT

   1     Subject
   2     Person
   3     Place
   4     Organization
   5     Government Technical Reports
   H     Help
->  1

PRESS       TO SELECT

   1     Current Events
   2     Business, Economics
   3     Computers, Sci/Tech, Medicine
   4     Law, Trademarks, Patents
   5     Social Sciences, Education
   6     Art, Literature, Entertainment
   7     Religion, Philosophy
   H     Help
->  3

PRESS       TO SELECT

   1     Agriculture
   2     Biology
   3     Chemistry, engineering, technology
   5     Earth sciences, energy
   6     Mathematics, physics
   7     Medicine, Allied Health
   H     Help
->  4

PRESS       TO SELECT

   1     Aerospace
   2     Civil
   3     Computer
   4     Electrical
   5     Materials
   6     Mechanical
   7     other choices
   H     Help
->  3
```

```
PRESS       TO SELECT

   1     Home, Business, Educational use
   2     Research & Technical information
   3     Telecommunications
   H     Help
->  2

PRESS       TO SELECT

   1     Research and popular magazines
   2     General periodicals
   3     Magazines (Full-Text)
   4     Newsletters on electronics
   5     Books on computers
   6     Encyclopedias
   7     other choices
   H     Help
->  1

PRESS       TO SELECT

   1     basic search
   2     field searching
   H     Help
->  1
```

This database carries a surcharge
Do you wish to continue ? (Yes/No) -> y

Enter your specific topic (e.g., VOICE AND DIGIT/ TRANSMIT/ ; (LIGHT/ OR OPTIC/) AND DATA PROCESS/ ; WORDSTAR OR WORD STAR). OMIT PUNCTUATION. TYPE H for Search Guidelines.

(type H for important examples
or B to back up)

-> robotics and expert systems

Is:
ROBOTICS AND EXPERT SYSTEMS
Correct ? (Yes/No) -> y

System is now searching the Computer Database, copyrighted 1987 for Information Access Company, Belmont, CA, and available through Dialog Information Services, Inc.

Case Conclusions

Implementation of the prototypes described in this case study demonstrates the feasibility of integrating diverse, yet functionally compatible, automation and information resources within an interoperable network. It also demonstrates that a variety of technologies exist today -- software, hardware, and telecommunications -- which can be blended and modified to make using information retrieval systems easier and the results more meaningful. But technology alone is not the answer. Advances in information retrieval systems are dependent on people -- end-users, intermediaries, vendor's, producers -- working together and being willing to modify and blend their skills in new ways.

DTIC is planning for the evolution of the STINET from prototype applications to a fully functional, integrated network. It has been said that "the best plan is only a plan ... unless it degenerates into work" (Ref. 18). DTIC is positioning itself to take advantage of evolving technologies to forward STINET development, but there are no quick technological solutions in STINET. DTIC must work to build-on, tailor, and accelerate the introduction of new technology. At the same time, we must work to effect changes in human processes so that the fullest benefit can be reaped from the application of new information technologies. The STINET plan has degenerated into work! The STINET work is of a truly synergistic nature in that the whole is much greater that the individual technologies, and STINET will only come into being through the combined efforts of many people.

FORECAST

Information leads to knowledge, and knowledge has always meant power, wealth, and control. Technology is reshaping the ways we communicate, distribute, and manage information. It works to bring information closer to its users. Introduction of technologies such as personal computers and user friendly search tools is creating a massive new market for information retrieval systems. During the next five years, there will be a restructuring of the products and a repositioning of the players in the information retrieval market.

Easy-to-use interfaces are exposing new users to the wealth of information available through information retrieval systems. As they earn learn to use its power, the perceived value of information will grow. As the amount of information continues to explode, so will the demand for information tailored to user needs. Gateway systems will evolve which present users with "views" of information personalized to meet their needs. Information "boutiques," organized by subject and interconnected, will form a virtual worldwide, multimedia library.

Users want answers! This will be the overriding challenge facing the information retrieval market. Decision support systems that incorporate current knowledge and can aid users in adding to that knowledge base will be the goal. As the generation of information continues unimpeded, users will demand sophisticated information analysis tools and instantaneous fact retrieval. This will dictate that high-value information be available in digital form so that users can rapidly access facts and analyze data.

Local systems for creating, storing and processing information will become a vital part of the information retrieval market. Selected information will be distributed on optical media for local use. Information on optical media will often be part of a complementary product line which includes online services. Users will be connected to local area networks that will encourage information sharing. This will swell the information flow and make it even more difficult to pick out facts or trends. It will also increase the need for information specialists and experts.

Information specialists will be the gurus of the new age. They will provide expertise in the politics of information and will be invaluable corporate resources. They will have to respond to users' critical needs for fast, accurate, complete information. They must be thoroughly knowledgeable about the sources of information, both corporate and external. They must understand emerging information technology well enough to offer a range of solutions to meet the needs of their clientele. This may include building "views" of information to meet individuals needs, tailoring interfaces to allow clientele to retrieve information from their "views" easily, and performing comprehensive searches for clients when exhaustive recall is essential. Most importantly, information specialists will be called upon to attest to the validity and reliability of data sources. They will have to ensure that external resources they use, or recommend to their clients, are credible. They will have to develop policies concerning how locally generated information will be controlled and validated. This will be critical; the use of incorrect information for decision making and planning could prove disastrous to an individual or to an institution.

The evolution of optical disk storage, computers and interface software provides the opportunity for rapid advances in information retrieval systems, but we are still a long way from having the world of information on a microchip at our fingertips. The information market will evolve in that direction as end-users, information specialists, information producers and vendors continue their partnership in the quest for knowledge.

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